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# Schizophrenic patients show facial reactions to emotional facial expressions

ANN M. KRING,[a] SANDRA L. KERR,[b] AND KELLY S. EARNST[a]
[a]Department of Psychology, Vanderbilt University, Nashville, TN, USA
[b]Department of Psychology, West Chester University, West Chester, PA, USA

**Abstract**

Facial reactions in schizophrenic patients were assessed via electromyography (EMG) in response to pictures of facial expressions. Male patients and nonpatient controls viewed photographs of positive and negative facial expressions while EMG activity from the corrugator and zygomatic muscle regions was recorded. Both schizophrenic patients and controls exhibited greater zygomatic reactivity in response to positive pictures than in response to negative pictures and greater corrugator reactivity in response to negative pictures than in response to positive pictures. Schizophrenic patients exhibited greater corrugator reactivity than did nonpatient controls. Implications for understanding emotion expression and perception in schizophrenic patients are discussed.

**Descriptors:** Facial expression, Emotion recognition, Schizophrenia, EMG

Following the championship game, the joyous faces of the winning team and the sad faces of the losing team often elicit expressions of happiness and sadness from the crowd. Similarly, watching another person laugh often makes us laugh, and watching another person's startled face may make us appear startled. That various facial expressions elicit similar facial reactions in observers has been well established in the empirical literature. For example, in a study using electromyography (EMG) to measure facial reactions, Dimberg (1982) found that participants showed more muscle activity associated with smiling (zygomatic muscle) when looking at pictures of happy faces than when looking at pictures of angry faces and more muscle activity associated with frowning (corrugator muscle) when looking at pictures of angry faces than when looking at pictures of happy faces. Not only did this study empirically demonstrate that observers mimic the facial expressions of others, it also demonstrated the power of using EMG to distinguish facial reactions to positive and negative emotional stimuli.

Since Dimberg's (1982) study, a number of other laboratories have found that facial expressions elicit similar facial reactions. A number of different stimuli have been used, including still photographs of facial expressions (Blairy & Hess, 1995; Dimberg, 1988; Hess, Blairy, & Philippot, 1995) and dynamic displays of facial expressions (McHugo, Lanzetta, Sullivan, Masters, & Englis, 1985; Laird et al., 1994; Wallbott, 1991). Pictures of facial expressions also elicit reports of experienced emotion that correspond to the emotion depicted by the picture (e.g., Dimberg, 1988; Laird et al., 1994).

Why do facial expressions elicit similar facial reactions among observers? Dimberg (1982, 1990) has argued that facial expressions are an emotional stimulus, much like slides, imagery, and film clips, and that the facial reactions represent one component of the emotional response to such stimuli. Similarly, a number of researchers have argued that the facial reactions are mimicking responses to the facial expressions. This facial mimicry has been hypothesized to be part of the process of *emotional contagion* (e.g., Hatfield, Cacioppo, & Rapson, 1994; Laird et al., 1994), and it has been postulated as one mechanism by which observers are able to recognize the emotion in others' facial expressions (e.g., Buck, 1988; Hess et al., 1995; Lipps, 1907; Wallbott, 1991). Wallbott (1991) provided indirect support for the hypothesis that mimicry aids in the recognition of emotion in pictures of facial expressions. Specifically, participants were videotaped while they judged emotions depicted in displayed pictures of facial expressions. Later, participants came back to the laboratory and watched the videotape of themselves viewing the facial expression pictures and were asked to judge what type of photograph they had been judging. Although participants judged the pictures of facial expressions more accurately than their own facial expressions, judgments of their own facial expressions were well above chance, suggesting that their own facial reactions (mimicry) may have helped them decide which type of facial expression they had viewed. In addition, participants' judgments of the pictures were significantly correlated with judgments of their own faces, particularly for happy and angry faces.

An alternative hypothesis posited to account for similar facial reactions to pictures of facial expressions is that the facial reac-

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Address reprint requests to: Dr. Ann M. Kring, Department of Psychology, 3210 Tolman Hall, University of California, Berkeley, CA 94720. E-mail: kring@socrates.berkeley.edu.

tions are actually reactions to other aspects of the task (e.g., difficulty) and not to the emotion depicted on the face. Blairy and Hess (1995) conducted a study to examine the effects of task difficulty on facial EMG reactions to pictures of facial expressions by using a decoding task designed such that identification of joy expressions was more difficult than identification of anger expressions. If task difficulty was responsible for facial EMG reactions, they hypothesized that corrugator activity would be greater in response to the more difficult joy pictures (i.e., frowning associated with effort and concentration) than the easier angry pictures. By contrast, if facial EMG reactions were a form of mimicry, they hypothesized that corrugator activity would be greater in response to angry pictures than joy pictures. Although the pictures of joy expressions were more difficult to decode, corrugator activity was greater in response to the angry pictures supporting the mimicry hypothesis. In sum, pictures of facial expressions elicit similar facial reactions in observers, and these reactions may aid in the recognition and perception of emotion depicted in the faces.

### *Emotion and Schizophrenia*

Recent work on emotion and schizophrenia has focused on both emotion expression and emotion recognition. With respect to emotional expression, schizophrenic patients have been found to be less expressive than nonpatient controls (e.g., Berenbaum & Oltmanns, 1992; Dworkin, Clark, Amador, & Gorman, 1996; Dworkin et al., 1993; Krause, Steimer-Krause, & Hufnagel, 1992; Kring & Earnst, 1998; Kring, Kerr, Smith, & Neale, 1993; Kring & Neale, 1996). In all of these studies facial activity was assessed using some type of observational coding system. However, in more recent studies of emotion in schizophrenia, EMG has been used to index facial expressivity (Earnst et al., 1996; Kring & Earnst, 1998; Mattes, Schneider, Heimann, & Birbaumer, 1995). For example, Mattes et al. (1995) found that schizophrenic patients exhibited more zygomatic activity during a happy film and a discussion of pleasant events than during a sad film and discussion of sad events and exhibited more corrugator activity during a sad film and discussion of sad events than during the happy film and discussion of pleasant events. Although patients exhibited slightly more corrugator activity than controls during the sad discussion, this difference was not significant. Additionally, patients did not differ from controls in their corrugator activity during the sad film, and they exhibited less zygomatic activity than controls during the happy film and pleasant discussion. Similarly, Kring and her colleagues (Earnst et al., 1996; Kring, Earnst, & Germans, 1999) found that schizophrenic patients exhibited greater zygomatic activity in response to positive emotional films than in response to negative emotional films and greater corrugator activity in response to negative emotional films than in response to positive emotional films, and EMG activity for schizophrenic patients was similar or in some instances greater than that for nonpatient controls. Moreover, patients' EMG activity did not appear to be significantly affected by neuroleptic medication (Kring & Earnst, in press).

Recent research on emotion recognition and schizophrenia has shown that schizophrenic patients perform more poorly on tests of facial emotion identification and facial emotion discrimination as compared with nonpatient controls (Kerr & Neale, 1993; Mueser et al., 1996; Salem, Kring, & Kerr, 1996). Although more powerful within subject studies have not been conducted to assess what, if any, effect neuroleptic medication has on emotion recognition, indirect evidence suggests that medication does not affect performance on emotion perception tasks (Mueser et al., 1996; Salem et al., 1996).

Although it remains unclear to what extent facial mimicry is involved in emotion recognition, if schizophrenic patients exhibit EMG activity consistent with the valence of the pictures, their inability to perform as well as controls on emotion perception tests may be due more to a lack of attention to task detail or to other artifacts of the testing situation, as suggested by Kerr and Neale (1993), who found that patients did as poorly on emotion perception tests as they did on control tasks. Such a pattern of deficits is consistent with a more generalized impairment rather than a specific emotion perception deficit. However, those results do not rule out an emotion perception deficit. If patients respond with corrugator and zygomatic muscle activity in ways that are consistent with the valence of the facial emotion presented and similar to the responses of nonpatient controls, it may provide an indication that they are able to perceive facial emotion without relying on traditional assessment measures that require verbal or written responses from patients. Further, recent evidence demonstrating that schizophrenic patients display EMG activity in response to emotional films (Earnst et al., 1996; Kring et al., 1999) suggests that they may also exhibit a similar pattern of EMG activity in response to pictures of emotionally expressive faces.

In the present study, we examined two related questions. First, do schizophrenic patients exhibit facial EMG activity in response to pictures of facial expressions? Based on other schizophrenia studies, we predicted that schizophrenic patients would show greater zygomatic activity in response to pictures of positive facial expressions than in response to pictures of negative facial expressions and greater corrugator activity in response to pictures of negative facial expressions than in response to pictures of positive facial expressions. Second, do schizophrenic patients and nonpatient controls differ in their EMG activity to pictures of facial expressions? Although schizophrenic patients have been found to exhibit less observable facial expression than nonpatient controls, other studies have found that schizophrenic patients and nonpatients do not differ in EMG activity in response to positive and negative emotional films. We predicted that patients and nonpatients would not differ in EMG activity in response to the pictures of facial expressions.

## Method

### *Participants*

Fifteen male patients from the Nashville Veterans Administration Hospital with diagnoses of either schizophrenia ($n = 13$) or schizoaffective disorder ($n = 2$) and 15 nonpatient controls recruited from the community participated. Diagnoses (DSM-IV; American Psychiatric Association, 1994) were determined using the Structured Clinical Interview for Axis I DSM-IV Disorders (SCID-I/P; First, Spitzer, Gibbon, & Williams, 1994) and extensive chart review. At the time of testing, 5 of the patients were in the hospital and the remaining 10 were outpatients. Ten of the patients were taking neuroleptic medication at the time of the study, and 5 were not.[1] Because medication side effects may interfere with facial activity, ratings of involuntary facial, extremity, and trunk movements were made using the Abnormal Involuntary Movement Scale

[1]Previous research measuring EMG activity among schizophrenic patients has found that neuroleptic medication does not significantly affect EMG response (Kring & Earnst, in press). Consistent with that finding, no differences in EMG activity or performance on the Facial Emotion Identification Test (Kerr & Neale, 1993) were found between those patients taking medication and those not taking medication in the present study.

(Guy, 1976), and ratings of extrapyramidal symptoms were made using the Rating Scale for Extrapyramidal Symptoms (DiMascio, Bernardo, Greenblatt, & Marder, 1976). Neither tardive dyskinesia nor severe extrapyramidal symptoms were present in these subjects (see Table 1). Nonpatient controls were interviewed to determine that they had no personal or family history of psychopathology. Demographic information for all participants is presented in Table 1. The patients and nonpatients did not significantly differ in age, years of education, marital status, or racial composition.

### *Picture Stimuli*

Participants viewed the Facial Emotion Identification Test developed by Kerr and Neale (1993) from photographs of facial emotion originally developed by Ekman and Friesen (1976) and Izard (1971). This test consists of 19 black-and-white photographs of facial expressions representing one of six different emotions (happy, surprise, sad, fear, anger, shame). The photographs have been transferred to videotape, and each facial expression is presented for about 10 s, with an intertrial interval of about 10 s.

### *EMG Recording*

Surface EMG activity was recorded from the left zygomatic and corrugator regions with miniature Beckman Ag/AgCl electrodes. The electrolyte used was TECA electrode gel, a commercially available product suitable for EMG recording (Fridlund & Cacioppo, 1986). EMG signals were amplified with a Coulbourn Instruments bioamplifier (S75-01) with high- and low-pass filters set to 8 and 250 Hz, respectively. Signals were then rectified and smoothed using a Coulbourn contour following integrator (S76-01) with a time constant of 20 ms. Sampling at 100 Hz, the amplified and integrated EMG signals were stored online for later analysis.

### *Procedure*

Electrodes were placed according to the recommendations of Tassinary, Cacioppo, and Geen (1989), and a 5-min baseline was recorded. Following the procedure of Dimberg (1982), participants were then instructed to relax and pay attention to the pictures during the Facial Emotion Identification Test presentation. EMG activity was recorded for all 19 trials. Following this initial presentation of the identification test, participants were shown the test again, but this time they were asked to look at each face and choose one of the six emotions (happy, angry, sad, surprise, shame, fear) listed on a response sheet that best described the expression.

**Table 1.** *Demographic and Clinical Characteristics*

| | Schizophrenic patients | | Nonpatient controls | |
|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* |
| Age (years) | 41.60 | 10.36 | 40.67 | 8.49 |
| Education (years) | 12.40 | 2.13 | 13.20 | 1.37 |
| Race (*n*) | | | | |
| Caucasian | 8 | | 8 | |
| African American | 7 | | 7 | |
| Marital Status (*n*) | | | | |
| Married | 2 | | 8 | |
| Divorced/separated | 8 | | 4 | |
| Single | 5 | | 3 | |
| Neuroleptic dosage ($n = 10$) | | | | |
| (CPZ equivalent) | 563.89 | 568.11 | | |
| No. of previous hospitalizations | 7.57 | 9.65 | | |
| Abnormal Involuntary Movements Scale | 2.13 | 2.04 | | |
| Rating Scale for Extrapyramidal Symptoms | 1.67 | 1.15 | | |

### *Data Scoring*

Mean zygomatic and corrugator activity (in $\mu$V) was computed for the first 7 s following onset of each trial (picture). Reactivity scores were computed by subtracting baseline EMG activity from each trial mean. Positive emotion reactivity scores were then computed separately for zygomatic and corrugator reactivity as the mean of the reactivity scores to the happy pictures. Similarly, negative emotion reactivity scores were computed separately for zygomatic and corrugator reactivity as the mean of the reactivity scores to the angry, fear, and sad pictures. One nonpatient did not complete the Facial Emotion Identification Test.

## Results

Descriptive statistics for the zygomatic and corrugator reactivity scores for the six individual emotions are presented in Table 2. Neither of the two rating scales for extrapyramidal symptoms and involuntary movements were significantly correlated with any of the EMG variables.

To examine whether the positive (happy) and negative (angry, fear, sad) pictures elicited different EMG responses among patients and controls, we conducted a 2 (group: schizophrenia, control) × 2 (emotion: positive, negative) repeated measures analysis of variance (ANOVA) separately for corrugator and zygomatic reactivity with group as a between-subjects variable and emotion as a within-subjects variable. For corrugator activity, the group main effect was significant, $F(1,28) = 6.56$, $p < .02$, indicating that schizophrenic patients demonstrated greater corrugator reactivity than controls in response to both positive and negative pictures.[2] In addition, the emotion main effect was significant, $F(1,28) = 4.19$, $p < .05$, indicating that both patients and controls exhibited greater corrugator activity in response to the negative pictures than in response to the positive pictures (see Figure 1). The Group × Emotion interaction was nonsignificant.

For zygomatic reactivity, neither the group main effect nor the Group × Emotion interaction significance. The emotion main effect approached significance, $F(1,28) = 3.43$, $p = .075$, indicating that both patients and controls tended to exhibit greater zygomatic reactivity to the positive pictures than to the negative pictures (see Figure 2).

To examine whether patients and controls differed in their relative response to positive and negative pictures, pattern scores (Fitzgibbons & Simons, 1992; Greenwald, Cook, & Lang, 1989) were computed by first standardizing (*z* scores) the corrugator and zygomatic reactivity scores across emotions and then subtracting

[2]Although the ANOVA is fairly robust to violations of the variance homogeneity assumption, Levene's test conducted on corrugator reactivity in response to the positive and negative pictures revealed significant heterogeneity of variance, $F(1,28) = 11.107$, $p < .01$. Levene's test for zygomatic reactivity was not significant. Thus, in addition to the ANOVA, we conducted a Welch test (Welch, 1947, 1949, 1951), which does not assume variance homogeneity and also provides control of Type I error (c.f., Tomarken & Serlin, 1986), with corrugator activity across pictures as the dependent variable. Similar to the ANOVA results, the group main effect was significant, Welch $F(1,21.62) = 11.10$, $p < .01$, indicating that schizophrenic patients exhibited greater corrugator reactivity than did nonpatients.

**Table 2.** *Zygomatic and Corrugator Reactivity ($\mu V$) in Response to Pictures*

| | Schizophrenic patients | | | | Controls | | | |
|---|---|---|---|---|---|---|---|---|
| | Zygomatic | | Corrugator | | Zygomatic | | Corrugator | |
| Trial | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Happy | 2.91 | 5.44 | 3.39 | 4.31 | 1.69 | 5.28 | 0.50 | 2.77 |
| Surprise | 3.92 | 5.21 | 3.07 | 6.63 | 0.28 | 1.80 | −0.14 | 2.52 |
| Sad | 1.17 | 2.47 | 4.88 | 5.31 | 0.34 | 0.93 | 1.45 | 2.17 |
| Fear | 1.99 | 3.99 | 5.10 | 6.05 | 0.43 | 0.89 | 1.35 | 2.05 |
| Anger | 1.13 | 2.48 | 5.42 | 6.02 | 0.49 | 0.76 | 2.45 | 2.80 |
| Shame | 1.02 | 2.00 | 3.29 | 2.50 | 0.19 | 0.93 | 0.20 | 2.73 |
| Baseline | 1.82 | 1.38 | 3.46 | 2.50 | 1.35 | 0.57 | 4.04 | 3.07 |

| | Pattern scores | | | |
|---|---|---|---|---|
| | Schizophrenic patients | | Controls | |
| Picture Type | *M* | *SD* | *M* | *SD* |
| Positive | −0.75 | 2.85 | 0.60 | 2.55 |
| Negative | −1.48 | 2.76 | −0.30 | 0.96 |

*Note:* Reactivity change scores were computed by subtracting baseline EMG activity from activity in response to pictures. Pattern scores ($z$) were computed by subtracting standardized corrugator reactivity from zygomatic reactivity.

corrugator reactivity from zygomatic reactivity for the positive and negative pictures. Using this index, scores greater than zero reflect greater overall zygomatic activity and scores less than zero reflect greater overall corrugator activity (see Table 2). These pattern scores were entered as the dependent variable in a 2 (group) × 2 (emotion: positive, negative) repeated measures ANOVA. Neither the group main effect ($p > .10$) nor the Group × Emotion interaction were significant, suggesting that the pattern of EMG responses did not significantly differ between patients and controls. The emotion main effect approached significance, $F(1,28) = 3.72$, $p = .06$, indicating that the pattern scores were more negative for the negative pictures (i.e., more corrugator activity) than for the positive pictures.

Similar to other studies using the Facial Emotion Identification Test (e.g., Kerr & Neale, 1993; Mueser et al., 1996; Salem et al., 1996), schizophrenic patients performed more poorly than the nonpatient controls. Proportion of correct scores was entered into a 2 (group: schizophrenic patient, control) × 2 (emotion: positive, negative) repeated measures ANOVA. This analysis indicated that schizophrenic patients ($M = .56$, SD $=.18$) were less able than controls ($M = .69$, SD $= .14$) to identify the negative expressions, as indicated by a significant Group × Emotion interaction, $F(1,26) = 5.36$, $p = .029$. Happy expressions were more easily identified than the negative expressions for both groups, $F(1,26) = 152.64$, $p < .001$. Both patients and controls identified the happy facial expressions with no errors.

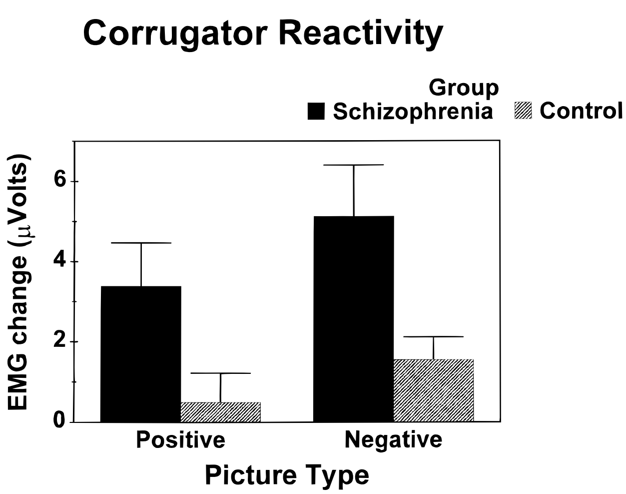


**Figure 1.** Corrugator reactivity to pictures of positive and negative emotional facial expressions for schizophrenic patients and nonpatient controls.

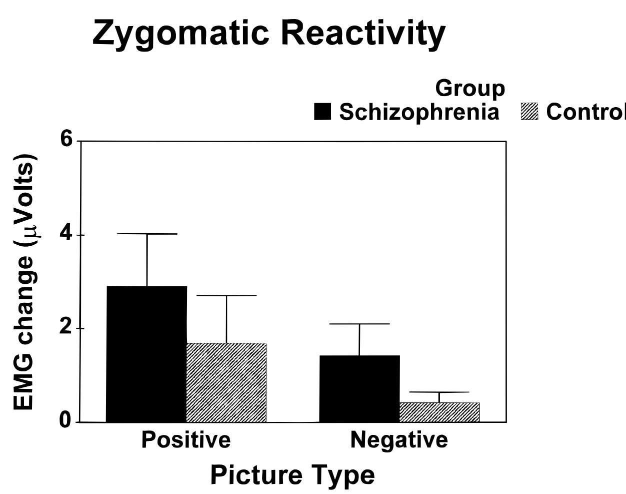


**Figure 2.** Zygomatic reactivity to pictures of positive and negative emotional facial expressions for schizophrenic patients and nonpatient controls.

## Discussion

We sought to determine whether schizophrenic patients would exhibit facial reactions to pictures of facial expressions and whether their responses would be similar to those of nonpatient controls. Replicating Dimberg's (1982) finding with nonpatients and consistent with our prediction, both schizophrenic patients and nonpatient controls exhibited differential EMG responses to pictures of positive and negative facial expressions. That is, both groups demonstrated greater zygomatic reactivity in response to pictures of positive, happy facial expressions than to pictures of negative facial expressions and greater corrugator reactivity in response to pictures of negative expressions than to pictures of positive expressions.

This finding provides further evidence that schizophrenic patients respond facially to emotional stimuli in a manner consistent with the valence of the stimuli. Although the differentiation of EMG response between positive and negative pictures for patients does not appear to be as large as that for nonpatient controls, they nonetheless did show differential responding depending upon whether they were viewing positive or negative facial expressions.

Schizophrenic patients exhibited greater zygomatic and corrugator reactivity (although only significantly greater for corrugator) in response to the positive and negative pictures than did nonpatient controls. At first glance, this finding appears inconsistent with results of previous studies in which schizophrenic patients have been less facially expressive than nonpatient controls (e.g., Berenbaum & Oltmanns, 1992; Dworkin et al., 1993, 1996; Krause, Steimer, Sanger-Alt, & Wagner, 1989; Kring et al., 1999; Kring et al., 1993; Kring & Neale, 1996). However, in studies using EMG as an index of facial expressivity patients exhibited similar or greater EMG reactivity in response to emotional stimuli as compared with nonpatient controls (Kring & Earnst, 1998; Mattes et al., 1995). Although EMG activity reflects both observable and unobservable facial activity, the magnitude of the responses obtained in this study suggests that the facial movement was subtle and probably not observable. Some researchers have argued that such subtle facial muscle activity may be less subject to the display rules and social contingencies that play a role in overt facial expressions (e.g., Cacioppo, Petty, Losch, & Kim, 1986). Thus, the EMG activity demonstrated by the schizophrenic patients may reflect facial reactions that are not as constrained by the social environment.

We did not, however, expect schizophrenic patients' corrugator reactivity to be greater than that of nonpatients. Even though the within group variability was greater among patients than among nonpatients, the group difference in EMG reactivity remained when conducting the Welch test (cf. Tomarken & Serlin, 1986), which does not assume variance homogeneity. Although the finding of greater corrugator reactivity among patients was not expected, Simons and colleagues reported a similar pattern of findings for participants identified as anhedonic. Specifically, anhedonic participants exhibited greater EMG reactivity to positive and negative emotional slides than did nonanhedonics (Fitzgibbons & Simons, 1992). However, an important distinction can be made between the anhedonic participants' responses in the Fitzgibbons and Simons study and the schizophrenic patients in the current study. Specifically, despite greater overall EMG activity, the pattern of anhedonics' responses indicated positive pattern scores for the positive slides and negative pattern scores for the negative slides. By contrast, although schizophrenic patients in the present study exhibited EMG activity that was consistent with the valence of the pictures, their pattern scores were negative for both types of pictures (although more so for the negative pictures), indicating a predominance of corrugator activity.

Why might schizophrenic patients be exhibiting more corrugator activity? Medication side effects may have contributed to overall greater tension in the corrugator region among patients. However, corrugator reactivity was not significantly correlated with ratings of involuntary movements or extrapyramidal symptoms. Moreover, patients' overall scores on the Abnormal Involuntary Movement Scale and Rating Scale for Extrapyramidal Symptoms were very low and clinically insignificant. Although it is likely that nonpatients would also have very few of these involuntary movement problems, we did not rate them and we therefore could not directly compare patients and nonpatients on these ratings scales. Thus, we cannot completely rule out medication side effects as a contributing factor to overall greater corrugator reactivity among patients.

An alternative explanation for the greater corrugator reactivity among patients is that their corrugator reactivity indicates the activity of other processes in addition to emotion. Indeed, several previous studies have demonstrated that corrugator activity often reflects processes not directly linked to emotion. For example, Smith and colleagues (Pope & Smith, 1994; Smith, 1989) have demonstrated that corrugator activity reflects not only unpleasant emotion but also anticipated effort. Cacioppo, Petty, and Morris (1985) suggested that the frown also indicates concentration or puzzlement. According to these accounts, viewing the pictures of facial expressions may have required more actual (or perceived) effort for patients than for controls. However, it remains unclear what about this experimental situation was more effortful for the patients. Alternatively, the patients may have been rather puzzled by the experimental situation. If this is the case, this puzzlement only manifested itself during the pictures; the patients and controls did not significantly differ in their baseline corrugator activity.

Nonetheless, the possibility that the schizophrenic patients' corrugator activity reflects more than emotional responding is also supported by findings of Kring et al. (1999). In that study, schizophrenic patients' corrugator activity was not significantly correlated with ratings of their observable facial expression, self-reports of unpleasant emotion, or skin conductance reactivity in response to negative emotional films. Among nonpatient controls, however, corrugator activity was significantly correlated with observable negative facial expressions, reports of unpleasant emotion, and skin conductance reactivity. Moreover, patients also exhibited significantly more corrugator reactivity than nonpatients, yet it was consistent with the valence of the films. That is, patients exhibited more corrugator reactivity to negative emotional films than to neutral or positive films. In sum, although schizophrenic patients' corrugator reactivity is an indicator of emotional responding, it also likely reflects other processes.

Similar to previous studies, the patients in the present study were not as accurate as nonpatient controls in identifying the specific emotion displayed on the faces in the pictures on the emotion identification test, particularly for negative facial expressions. However, their zygomatic and corrugator responses to the facial stimuli were as expected and similar to the pattern shown by the controls. To the extent that mimicry is involved in emotion perception, these results suggest that patients are, at least to some degree, perceiving the emotions expressed in the faces. The use of facial EMG methodology as a means of assessing perception of emotion is the first attempt of which we are aware to measure recognition of emotion without relying on pen and paper tests. Such traditional methods are more likely to yield results contaminated by schizophrenic patients' well-documented generalized deficit than is the EMG method, which does not require patients to use a scoring sheet to record responses. Thus, problems presumed to underlie the generalized deficit, such as attentional limitations and motivation, may be reduced. Future research should include neutral in addition to positive and negative facial stimuli to further demonstrate that EMG activity occurs in a pattern that suggests differential valence responding rather than in response to any facial stimuli.

It remains unclear whether patients' differential EMG responding is specific to emotional faces and/or valence (positive, negative). Faces were a part of the films presented in the studies of Kring and colleagues (Earnst et al., 1996; Kring et al., 1999). Thus, patients' EMG responses may have been in response to the faces in the film rather than the emotional content of the film per se. However, in a study with nonpatients, Cacioppo, Bush, and Tassinary (1992) found similar magnitudes of zygomatic region responses to pictures of pleasant faces and to pictures of pleasant nature scenes and similar magnitudes of corrugator region responses to pictures of unpleasant faces and to pictures of unpleasant nature scenes, suggesting that the valence of the stimulus was more important than the faces in determining EMG response. Nonetheless, future studies with schizophrenic patients should present emotional stimuli without faces (e.g., disgust film showing an arm amputation) to determine whether the same patterns of EMG responses are found.

The present study was limited by the relatively small sample size and the lack of women as participants. Although it seems unlikely that medication affected EMG reactivity, we cannot conclusively rule out this possibility. Nonetheless, the results suggest that male schizophrenic patients respond facially to emotional material, but perhaps at a level that is not likely to be detected by observers. Unfortunately, we were not able to obtain ratings of observable facial reactions to the pictures. The finding of greater EMG activity among patients was unexpected and may be specific to this sample. Nonetheless, the findings of this study should be extended by investigators using other types of stimuli.

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